FLOOD CONTROL OF THE MISSISSIPPI RIVER

ADDRESS

BY

COL. C. McD. TOWNSEND, U. S. A.

PRESIDENT OF MISSISSIPPI
RIVER COMMISSION

BEFORE THE

NATIONAL DRAINAGE CONGRESS

ST. LOUIS, MO.

APRIL 11th, 1913.

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MISSISSIPPI RIVER LEVEE ASSOCIATION

Scimitar Bldg., Memphis, Tenn.

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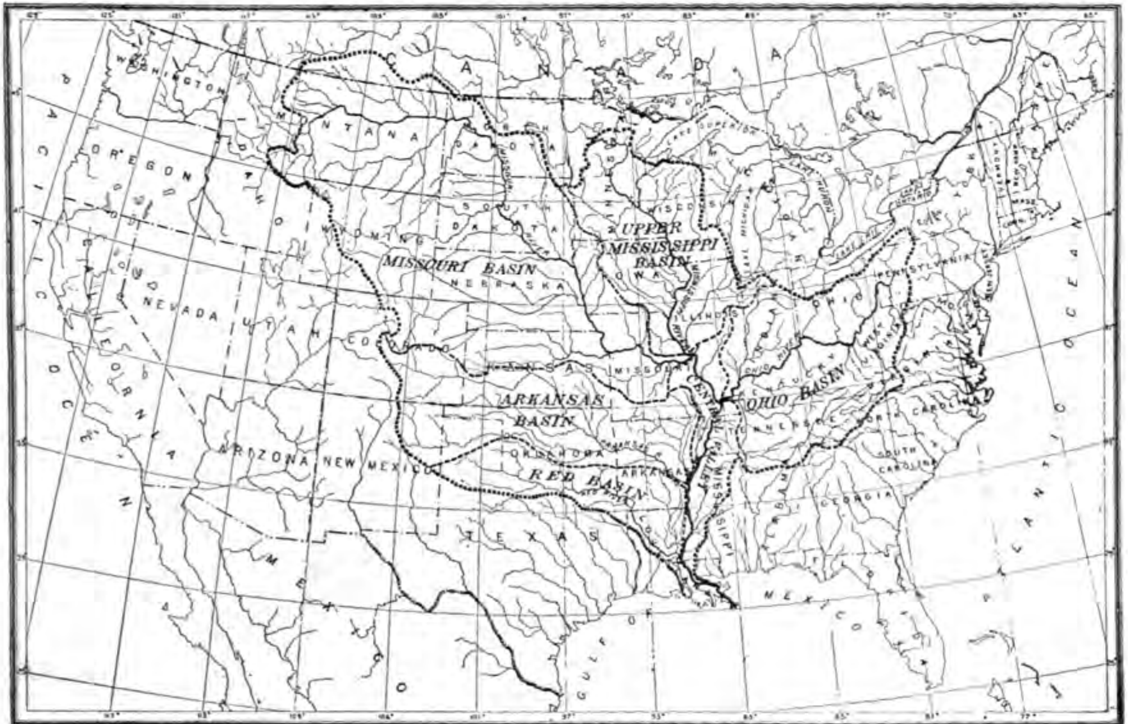
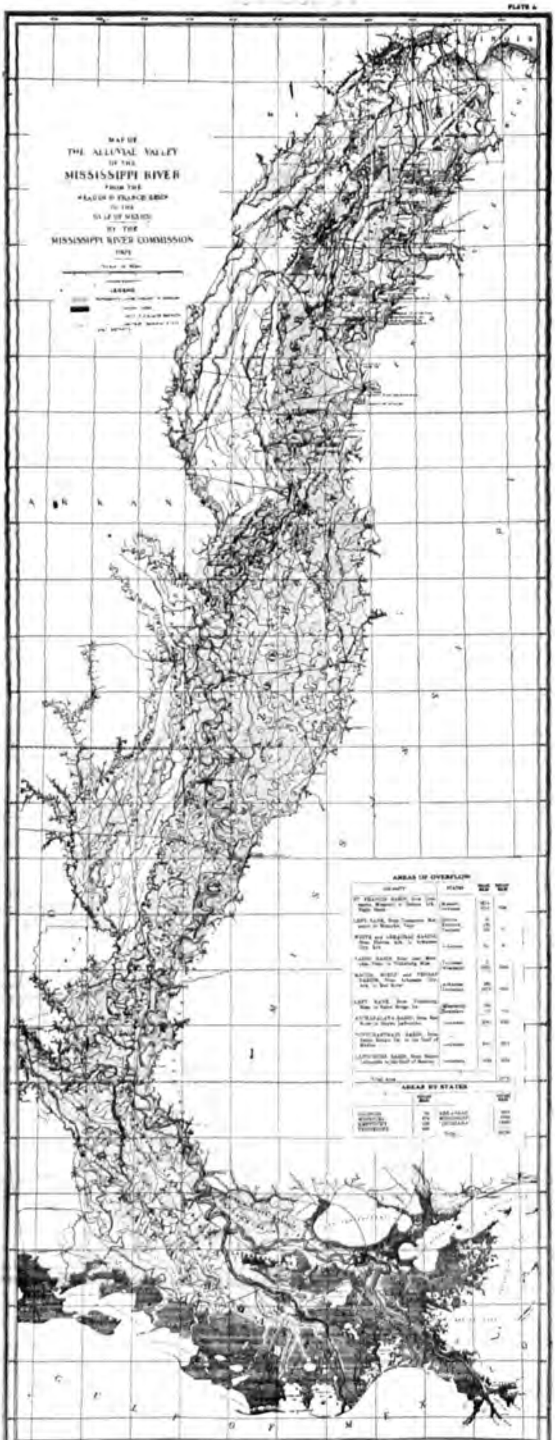


MAP OF THE

DRAINAGE BASIN OF THE MISSISSIPPI RIVER

Prepared by the Mississippi River Levee Association

Total Area 1,240050 Sq. Miles.


MAP OF
THE ALLUVIAL VALLEY
OF THE
MISSISSIPPI RIVER
FROM THE
TO THE
BY THE
MISSISSIPPI RIVER COMMISSION
LEGEND
AREAS OF OVERFLOW
AREAS BY STATES

Flood Control of the Mississippi River.

Mr. President and Gentlemen—The subject of land drainage is intimately associated with that of river improvement. The cultivation of the soil largely increases the amount of sediment entering our streams; the direction of the furrow markedly affects the amount of rain water that flows from its surface, and every ditch or subsurface drain promotes a more rapid flow into our rivers during floods and possibly affects their discharge during low water. On the other hand, no satisfactory system of land drainage can be accomplished in a country subject to periodic overflow by river floods. In the Mississippi Valley, protection from floods is absolutely required before any regular system of drainage can be inaugurated. The overflow is so great and the amount of sediment carried by the river so large, that the drains would be annually destroyed or filled. The floods not only insure the destruction of any crops that might be planted, but also usually occur at such times as to prevent the harvesting of a second crop the same year. A discussion of the means of preventing floods in the Mississippi Valley is therefore particularly appropriate at this meeting. In a paper read before a levee convention in Memphis last September, I briefly discussed the various means of flood control which had been suggested to the Mississippi River Commission. This afternoon I propose to confine my remarks to the three methods in which the public appears most interested, i. e., reforestation, reservoirs, and levees.

Before entering upon such a discussion, it is desirable to have a clear conception of the sources from which floods arise.

As you will recall, the greater Mississippi Valley is bounded on the east by the Appalachian chain and on the west by the Rocky Mountains. These mountain ranges exert a great influence on its floods. The winds blowing from an easterly direction deposit most of the moisture they absorb from the Atlantic Ocean on the eastern slope of the Alleghenies, and therefore cause little rain in the Mississippi Valley; the Rocky Mountains intercept the moisture from the Pacific Oceans. While showers occur from winds blowing over the Great Lakes, the original source of the floods of the Mississippi is to be sought in the Gulf of Mexico.

During the winter and spring the land of the Mississippi Valley, no matter what its soil or the nature of its covering, is cooler than the waters of the gulf, and a southerly wind becoming sat-

urated with moisture as it passes over the water will precipitate that moisture on the land in copious rains, or in snow when the temperature is sufficiently low. A wind from the southwest sweeps up the Ohio Valley; one from the south carries moisture to the upper Mississippi; one from the southeast to the valleys of the Arkansas and the Missouri; but in all cases there is a tendency for the greatest rainfall to occur near the coast, and gradually to decrease as the wind currents travel inland. Thus the average annual rainfall at New Orleans is 60 inches, at Memphis 52 inches, at Cincinnati 42 inches, at Pittsburg 36 inches, and at St. Louis 40 inches. At the headwaters of the upper Mississippi it is but 25 inches, and at the headwaters of the Missouri but 13 inches. Though floods do not arise from mean conditions, but from exceptional rainfall when six to ten inches fall in a week, these figures are good indices of flood volumes, as we find from observation by the geological survey at Williston, North Dakota, that the flood discharge of the upper reaches of the Missouri is about one second foot per square mile of drainage area; measurements at St. Paul give an extreme flood discharge for the upper Mississippi of slightly over two second-feet per square mile. In the Ohio it is about six second-feet, and in the Ouachita, St. Francis and Yazoo rivers from 8 to 10.

From the above it will be seen that the rainfall is very unequally distributed over the Mississippi Valley, being least at the upper sources of the tributaries, and rapidly increasing as you approach the main stream, though an exception is to be noted in the southern tributaries of the Ohio, whose sources are nearer the gulf than are their outlets.

The maximum discharge of the upper Mississippi River is estimated at 450,000 second-feet; the Missouri, 900,000; the Ohio, 1,400,000; the Arkansas, 450,000; and the Red, 220,000. There is also a large discharge from the Yazoo, St. Francis, White, Tensas and Ouachita Rivers. The maximum discharge of the Mississippi during the flood of 1912 was about 2,000,000 second-feet at Cairo, and 2,300,000 at the mouth of Red River. It overflows its natural banks when the flow exceeds 1,000,000 second-feet.

While the influence of forests on streamflow has received little attention in this country until recently, the scientists of Europe have discussed the subject pro and con during the past 40 years. It is generally accepted by both sides that the leaves falling from forest trees as they decay form a humus which has a large capacity to absorb water, and that when the forests are felled this humus is seriously injured by forest fires. It is also admitted that snow is more rapidly melted when it is exposed to the direct rays of the sun in an open field than when sheltered from such action in a forest. In fact, it has been found by the United States forestry service from experiments recently made in the White Mountains that the flow from cleared fields under such conditions is about twice that from forests. The forest advocates claim that this is sufficient proof that forests absorb water during flood periods, which perco-

lates through the ground and flows from springs later in the season, thus reducing flood heights and increasing the low water flow of rivers. Its opponents do not admit that the problem is thus easily solved. They claim that floods do not arise from the melting of snow by the direct action of the sun; that this process is so slow that the water which flows off would not raise a river to mid-stage; that floods occur when on a layer of snow there falls a copious supply of rain, and both the rain and melted snow enter the stream simultaneously; and that under such conditions, the forest, instead of being beneficial, is injurious. On cleared land the wind tends to blow the snow from the ridges and piles it in immense masses in the ravines, while in the forests the snow is uniformly distributed. A few days of sunshine dries out the ridges in the open field and melts sufficient snow in the forest to saturate with water the underlying humus.

If a heavy rainfall then occurs, the forest humus, being saturated, can absorb no more water, and the combined rain and snow of the forest flows into the streams, while in the cleared land, the ridges having dried out, absorb a large portion of the rainfall, and the snowdrifts expose a much smaller surface to the action of rain. Moreover, during periods of great drouth the forest humus and long, deep tree roots also absorb more water than grass and farm crops, and retard the run-off at a time when it is most needed for low water navigation. They therefore maintain that a forest is a fair-weather friend of some use in regulating the mid-stages of a river, but an utter failure when most needed, that is, during extreme floods or extreme low water. While I consider this discussion valuable, my objections to reforestation are not based solely on a scholastic argument.

It requires from 20 to 50 years to produce a good forest growth, and over a century for the leaves of that forest to decay in sufficient quantities to produce the humus which will be satisfactory as an absorbent of rainfall. We cannot afford to delay the drainage of the Mississippi Valley even to produce the forest growth, without taking into consideration the time required for the humus to form. We are more vitally interested in the height that the river will attain in the next few weeks than in what will occur in the year 2013.

It is also pertinent to this discussion to determine what would be the extent of the forest reservation, which would be required to reduce the flood heights on the Mississippi River a given amount. To solve this problem it is necessary to make certain assumptions, and for purposes of argument we will take it for granted that reforestation will reduce the flood discharge of a stream one-half. The Mississippi flood of 1912 attained the greatest height of any then recorded at all gauge stations except at Vicksburg. That of January and February, 1913, while five feet lower at Cairo, was the next highest flood at Memphis, and for a considerable distance along the river. We will endeavor by reforestation to reduce the

flood of 1912 to the heights attained in the winter of 1913. For this purpose it will be necessary to reduce the maximum discharge of the river 500,000 second-feet. It will also be necessary to distribute this reduction among the tributaries, reducing the maximum discharge of the Missouri River from 900,000 to 700,000 second-feet, that of the upper Mississippi from 450,000 to 350,000, and that of the Ohio River from 1,400,000 to 1,200,000.

As stated in the introductory remarks, the flood discharge of the Missouri River at its headwaters is about one cubic foot per second square mile of drainage area, and if the reduction in discharge of one-half is to be secured by reforestation, two square miles of forests would be necessary for every second-foot of reduction of flood discharge, or 400,000 square miles of forests to reduce the discharge of the Missouri River 200,000 second-feet. At the headwaters of the upper Mississippi the ratio of flood discharge to drainage area is about two second-feet per square mile. A reduction of this discharge by one-half would require a forest reservation of 100,000 square miles to reduce the floods of the upper Mississippi 100,000 second-feet. On the Ohio River the ratio is six to one, and it would therefore require forests at the headwaters of the Ohio having an area of 66,000 square miles to reduce its flow 200,000 second-feet. In other words, to reduce the height of a flood at Memphis by reforestation at the headwaters of the river from that of 1912 to the next highest on record, would require a forest reservation of about 566,000 square miles, an area exceeding that of the portions of Montana and Wyoming drained by the Missouri River and the States of North and South Dakota, the portion of Minnesota drained by the upper Mississippi River, and the States of Iowa, Wisconsin, Illinois and Indiana. But even such a forest reservation would afford only partial protection, and large expenditures for levees would still be required. Under the above assumptions, to prevent any overflow by reforestation would necessitate a practical abandonment of the valley for agricultural purposes, and the development of an extensive irrigation system to produce tree growth in arid regions of the West.

It is therefore apparent that even under the most extravagant claims of forestry advocates, reforestation as a means of reducing flood heights on the Mississippi River requires the conversion of too much farming land into wilderness to be practicable. The waste land that can profitably be converted into forest reservations is too limited in area to produce an appreciable effect on the floods.

To have retained the Mississippi flood of 1912 within its banks would have required a reservoir in the vicinity of Cairo, Ill., having an area of 7,000 square miles, slightly less than that of the State of New Jersey, and a depth of about 15 feet, assuming that it would be empty when the river attained a bankfull stage. If the site of such a reservoir was a plane surface the quantity of material to be excavated in its construction would be over 100,000,000,000 cubic yards; and its estimated cost from 50 to 100,000 million dollars.

Such a volume of earth would build a levee line 7,000 miles long and over 150 feet high.

Cairo is the logical location for a reservoir to regulate the discharge of the lower Mississippi. It will not only control the floods from the Ohio, but also the discharge from the Missouri and upper Mississippi. But if the reservoirs be transferred from the mouths of the tributaries to the headwaters, their capacity must be largely increased. No two floods have the same origin, unless they are referred back to the Gulf of Mexico. The wind bloweth where it listeth. If the prevailing winds in the early spring are from the southwest, the southern tributaries of the Ohio furnish the crest of the year's flood; if more nearly from the south, reservoirs will be required on the streams of Ohio, Indiana and Illinois, a slight varying of the wind will produce a flood in the upper Mississippi, while if it blows from the southeast the principal sources of trouble will be the Red, Arkansas and Missouri Rivers. To control the flow of every stream in the Mississippi Valley by reservoirs is a pretty large job, even for the United States government, but that is what the control of the Mississippi during floods by reservoirs signifies.

The advocates of the control of the floods of the Mississippi by reservoirs do not, however, have in mind any such radical control as is above indicated. They limit the control to the headwaters of the various tributaries, and while every stream that flows in the valley may be considered a headwater of some tributary, I judge from the discussions of the reservoirs and their proposed employment for power purposes, which requires a considerable heighth of dam, that by headwaters is meant the sources of the rivers in mountainous countries as distinguished from the more level plains, and more specifically the sources of the Missouri above the mouth of the Yellowstone, those of the upper Mississippi in the State of Minnesota and those of the Ohio in the Appalachian range.

The flood which is now devastating the country affords data for determining the effect of such a system of reservoirs and its lessons are the more valuable because no effort is necessary to refreshen the memory. When on April 2 the gauge at Cairo attained a height of 54 feet there was flowing down the Mississippi River at least 2,000,000 cubic feet of water per second. It requires about 11 days for a flood wave to be transmitted the 966 miles between Pittsburg, Pa., and Cairo; on March 22 the Pittsburg gauge read 5.3 feet, which is produced by a flow in the Ohio River at that locality of about 15,000 second-feet. In ten days the flood travels the 858 miles between St. Paul, Minn., and Cairo; on March 2 the reading of the St. Paul gauge was 0.5 feet, corresponding to a discharge of the Mississippi of about 2,500 second-feet. In eight days the effect of a flood at St. Joseph, Mo., is felt at Cairo; on March 25 the gauge at St. Joseph read minus 0.1 foot, representing a discharge of the Missouri River of about 17,000 second-feet. If a system of reservoirs had been constructed which would have prevented all flow from the Allegheny, the Monongahela, the Mississippi above St.

Paul and the Missouri above St. Joseph, it would have reduced the 2,000,000 second-feet discharged by the Mississippi River at Cairo on April 2 less than 35,000 second-feet.

The water which passed Cairo on the 2d of April came principally from the White and Wabash, and the lower tributaries of the Ohio, and after the water of these rivers started to subside the flood from Cincinnati, though increasing from 57 to 69 feet on the gauge, could increase flood heights at Cairo less than one foot. The flood of 30 feet at Pittsburg on March 28 produced its effect on the Cairo gauge day before yesterday (April 8). It has prolonged the flood without increasing its height.

The proposed system of reservoirs would have cost hundreds of millions of dollars and its effect on this year's flood height of the lower Mississippi could not possibly have exceeded six inches.

Neither the rain nor snow which falls upon the mountainous portions of the Mississippi watershed has much effect upon the floods of the lower river. The principal source of the floods is the great alluvial plain between the mountains. As I have pointed out, excepting the southern tributaries of the Ohio, the rainfall is relatively slight at the upper sources of the tributaries and their maximum flood discharge does not usually coincide with that of the mid-valley.

Great floods do not arise from average conditions, but from exceptional variations such as are caused by a series of heavy rains rapidly succeeding one another. Each rainstorm starts down a stream a flood, the volume of which can be absorbed by a reservoir with comparatively little trouble, but if a second storm sweeps over the valley the reservoir to be effective must be emptied or its capacity doubled. To hold all the excess rainfall till low water would require reservoirs of enormous capacity. Economic considerations usually require that the reservoirs should be emptied as soon as the crest passes, in order to utilize the same space for a second rainfall; so that while reducing the crest of a flood at a given locality they necessarily prolong the period during which the river remains at a high stage.

The water which is abstracted from the Gulf of Mexico is usually precipitated in the Mississippi Valley within a period of two days. The return flow extends over a period of two or three months. The sum of the maximum discharges of the various tributaries of the Mississippi River is nearly 4,000,000 second-feet, while the greatest measured discharge of the river itself is about 2,300,000. This apparent discrepancy arises from the fact that the floods of the tributaries do not reach the gulf at the same time. The crest of the Ohio River flood usually passes down the river in March or April, that of the Missouri in May or June. Moreover, the same law applies to the tributaries of a tributary. The waters of the southern branches of the Ohio tend to discharge into that river before those in Ohio, Indiana and Illinois.

By the construction of reservoirs this beneficent law of nature

is deranged. Instead of the crest of the flood of one stream passing dwon the river before that of another reaches it, two prolonged high stages will obtain which will tend to synchronize and the resultant combination may be higher than either flood would have been by itself.

A system of flood control, designed to be satisfactory for one city may be most disastrous to another locality further down stream. If a system of reservoirs had been in operation in the Allegheny and Monongahela Rivers during last January, it would have protected Pittsburg from overflow and diminished the flood at Cincinnati when it was 50 feet on the gauge, but only to increase it when it attained a height of 60 feet. And this effect would have been propagated to the gulf.

Pittsburg, moreover, would never consent to such a manipulation of reservoirs on the upper tributaries of the Ohio, as would insure the reduction of floods at Cincinnati or on the lower Mississippi. Source stream control on the Mississippi River and its tributaries would therefore soon reduce itself to the question whose ox is to be gored.

While the use of forests or reservoirs as a means of flood control is still in an experimental stage all over the world, the employment of levees for this purpose has been tested for centuries. The Po, Rhine, Danube, Rhone and other rivers of Europe have been successfully leveed. The laws governing the flow of water in a confined stream have been carefully studied and the construction of levees is just as suspectible of mathematical analysis as other engineering problems. There is an element of uncertainty in all the forces of nature. No one can say positively, for instance, that St. Louis may not at some future time experience an earthquake, or a cyclone of greater intensity than that which swept over the city in 1896. There is also a possibility that there will be some combination of meteorological conditions which will create a flood of greater volume than has heretofore occurred in any drainage area. But the height of which levees should be constructed is as susceptible of determination as the strains to be permitted in an office building due to wind pressure or the moving load allowable on a bridge. The city engineer solves a similar problem whenever he constructs a sewer to carry off the storm water from the city streets.

Nor is there any evidence either that floods have been increasing in recent years due to the cutting off of forests or that the beds of our main rivers are rising as they are leveed. The effect of forests on rainfall in Europe have been carefully investigated by Profs. Schlichting and Hagen. The records at London, Paris, St. Petersburg and other localities where the rain has been recorded for long periods fail to show any tendency to an increased fall in recent years.

The meteorological records of the United States have not been maintained a sufficient length of time to be of much value in solving the problem. Such data as we possess indicate that the flood

discharge has not increased in recent years. The greatest flood of the Mississippi at St. Louis occurred in 1844, the next largest in 1785. On the great lakes the high water of 1838 is the greatest on record. In the Ohio the flood of 1884 exceeded that of 1913 at Cincinnati, and that of 1832, while five feet lower at Cincinnati, was five feet higher at Pittsburg than this year's flood. The gauge records at the bridges over the upper Mississippi, which cover a period of 30 years, would indicate that the flow from Minnesota and Wisconsin, where the forests have been most extensively destroyed during the period, has been slightly improved, though the river shows signs of deterioration where it receives the flow from the prairie lands of Iowa and Illinois. They appear to confirm the conclusions of the German forestry authorities that the influence of forests on drainage is concealed by other causes more powerful in their effects.

The flood of 1912 was not due so much to excessive precipitation as to the fact that the surface of the ground was frozen over the States of Illinois, Indiana and Ohio, so that there was not the soil absorption of rain water that usually occurs.

There is not the remotest connection between deforestation and the disasters which have just occurred at numerous cities in Ohio and Indiana. The flood of 1832 was similar to that of 1913, but it was discharged by streams of the dimensions the Creator intended they should have. Since then cities have sprung up and land has become so valuable that riparian owners have encroached upon the waterways. Where the floods formerly flowed untrammeled, factories and dwellings have been constructed and numerous bridges have further restrained the stream's discharge. When His laws are violated, though slow to anger, the Creator occasionally asserts His might and the works of man crumble before Him. If it would accomplish any useful purpose, I could name other cities where conditions are as dangerous as at Dayton or Columbus, but the lessons of the flood will be forgotten with the burial of its dead.

The question of the rise of the river bed by levee construction has been exhaustively investigated. On the Rhine the maximum effects were observed at Dusseldorf, where the same discharge at low water appears to attain a height eight inches greater today than it did one hundred years ago, while the same discharge at high water has lowered about one foot in a century. On the Po the maximum observed change in low-water conditions was 0.02 of a foot per year, but it is by no means proven that even these small changes have resulted from levee construction. They may have arisen from the improvements in the river bed which were made simultaneously with levee construction. The observations of the Mississippi River Commission agree with the Dusseldorf observations, in that the Mississippi River appears to be slightly enlarging its section, at least at mid-stages.

The present contents of the adopted levee line of the Mississippi River is about 243,000,000 cubic yards. It has been computed

that with an addition of 200,000,000 cubic yards and at an estimated cost of $57,000,000 this line would be safe against any flood which has occurred in the Mississippi River. This sum, though large, is less than $4 per acre of land protected from overflow, and appears insignificant when compared with the amounts which are being expended per acre for irrigation purposes in the arid West. The increase in the value of land on the damage caused by one overflow like that of 1912 would pay for the completion of the levee system.

When a levee line contains but one-half the material that safety requires, crevasses afford no argument against levee construction. During the flood of 1912 hundreds of miles of levees were topped with earth in sacks to a height of from two to four feet, to prevent the water flowing over them, and water was seeping through their narrow bases in copious streams, which was unheeded until mud began to flow. The levee which failed at Beulah, Miss., this winter was held till the pile of sacks exceeded 20 feet in height.

The holding of 1,525 miles of such levees through the flood of 1912, even though 13 miles failed, is a powerful argument in favor of a properly constructed levee line. There was no failure where levees were built to a suitable grade and adequate dimensions, as in the upper Yazoo district.

Conclusion.—While of the opinion that levees afford the only practicable method of controlling the floods of the Mississippi River, in conclusion I desire to state that I am strongly in favor of both reforestation and reservoir construction, but limited to the purposes for which they are adapted, just as I am in favor of reinforced concrete for small bridges, though not considering it applicable to one spanning the lower Mississippi River. The price of lumber today is a sufficient argument for planting trees, without attempting to associate forestry with the climate or with the flood conditions on our rivers. If the federal government or the states do not conserve the forests, the time will soon come when the farmer will raise his crop of timber just as he now plants a field of wheat, and for the same reason, because it will pay him to use his waste land for the purpose.

Reservoirs are necessary for municipal water supplies, for purposes of irrigation, for the development of power and for feeders to canals. They can be successfully employed on small streams to diminish floods or increase the low water flow. The trouble arises when an attempt is made to utilize them for too many purposes at the same time. There must be a paramount issue to which the others will be subsidiary.

If the main purpose is to supply a city with water only the excess can be used for power development. If the dams are constructed to produce power, the reduction of floods and the improvement of river navigation must be subordinate thereto. Water required for irrigation can only be used to develop power when the dam of the storage reservoir is given a greater height than is necessary for its flow over the land to be reclaimed.

During the next decade there will be an enormous development of reservoirs both for irrigation and for power purposes, which I hope will be utilized to correct man's folly and prevent many disasters similar to those which have recently occurred in Indiana and Ohio. While the control of the lower Mississippi by reservoirs is impracticable, there are numerous smaller streams where they can be used with excellent results.

It is questionable, however, whether such reservoirs should be built with the control of our rivers the first object of consideration. It will, to be sure, saddle the cost on the United States treasury, but to close down a power plant and stop the growth of crops every time the navigation of a minor stream is interfered with, I do not consider would be a wise proceeding.

I am also skeptical of government ownership. It may have worked satisfactorily in irrigation projects, but my own experience with government ownership of water power makes me suspicious. I have found that when the government buys water power, the power companies consider it worth $25 per horsepower per year, but when conditions are reversed, and an attempt is made to lease it, the price drops to 10 cents.

Wherever it will pay to build a dam for power purposes, capital stands ready to construct it, if it can obtain the franchise. By regulating the franchise, the reservoir can also be used to restrain local floods.

The systematic conservation and regulation by the government of a river from its source to its mouth sounds most attractive, suggesting a scientific solution of every problem of river hydraulics, but instead I greatly fear that it is the voice of a siren luring the people to an open pork barrel for every stream in the United States.

Bill for Flood Prevention

Introduced by Congressman B. G. Humphreys of Mississippi and by Senator Joseph E. Ransdell of Louisiana

A BILL

To Prevent Floods on the Mississippi River and Improve Navigation Thereon.

Whereas, the Mississippi River is the nation's drainage ditch, and its flood waters, gathered from thirty-one states and the Dominion of Canada, constitute an overpowering force which breaks the levees and pours its torrents over many million acres of the richest land in the Union, stopping mills, impeding commerce, and causing great loss of life and property; and

Whereas, these floods are national in scope, and the disasters they produce seriously affect the general welfare; and

Whereas, the state, unaided, cannot cope with this giant problem; and

Whereas, the control of the Mississippi River is a national problem, and the preservation of the depth of its water for the purpose of navigation, the building of levees to maintain the integrity of its channel, and the prevention of the overflow of the land and its consequent devastation, resulting in the interruption of interstate commerce, the disorganization of the mail service, and the enormous loss of life and property impose an obligation which alone can be discharged by the general government; therefore,

Be it enacted by the Senate and House of Representatives of th United States of America in Congress assembled, That for continuing the improvement of the Mississippi from the head of the passes to mouth of the Ohio River, including the salaries, clerical, office, traveling and miscellaneous expenses of the Mississippi River Commission, with a view to securing a permanent channel depth of nine feet, preventing the banks of the river from caving, and protecting the valley from floods, the sum of $12,000,000 is hereby appropriated, to be paid out of any money in the treasury not otherwise appropriated, and to be immediately available, which shall be expended under the direction of the secretary of war in accordance

with the plans, specifications and recommendations of the Mississippi River Commission, as approved by the chief of engineers, for the general improvement of the river, and for surveys, including the survey from the head of the passes to the headwaters of the river, in such manner as, in their opinion, shall best improve navigation and promote the interests of commerce at all stages of the river, and for the building of levees between the head of the passes and Cape Girardeau, Mo.; provided, that on and after the passage of this act the secretary of war may, by hired labor or otherwise, carry on continuously the plans of the Mississippi River Commission as aforesaid, to be paid for as appropriations may from time to time be made by law, not to exceed in the aggregate $48,000,000, exclusive of the amounts herein and heretofore appropriated; provided, further, that the authorized sum last named shall be used in prosecuting the improvement for not less than four years beginning July 1, 1915, the work thus done each year to cost, approximately, $12,000,000. Provided, further, that of the money hereby appropriated and authorized to be expended the sum of $9,000,000 per annum, or so much thereof as may be necessary, shall be expended in the protection, repair and construction of levees; and the balance in the construction and repair of bank revetment, and for works in the interest of navigation, including the construction or suitable and necessary dredge boats and other devices and appliances, and in the maintenance and operation of the same.

Sec. 2. That the water courses connected with the said river, and any harbors upon it now under control of the Mississippi River Commission and under improvement, may, in the discretion of said commission, upon the approval of the chief of engineers, receive allotments for improvements now under way or hereafter to be undertaken, to be paid for from the amounts herein appropriated or authorized.

Sec. 3. That no money herein authorized to be appropriated shall be expended in any established levee district in the construction or repair of levees therein unless and until assurances have been given satisfactory to the commission that local interests protected thereby will contribute for such construction and repair a sum equal to one-third of such sum as may have been allotted by the commission for such work; provided, that such contributions shall be expended under the direction of the commission and in such manner as it may require or approve, but no contributions made by any state or levee district shall be expended in any other state or levee district except with the approval of the authorities of the state or district so contributing.